

Utah State University

DigitalCommons@USU

Presentations

Materials Physics

6-25-2014

Variations in Cathodoluminescent Intensity of Spacecraft Materials Exposed to Energetic Electron Bombardment

Justin Dekany
Utah State University


Justin Christensen
Utah State University

JR Dennison
Utah State University

Amberly Evans Jensen
Utah State University

Gregory Wilson
Utah State University

Todd Schneider
NASA MSFC
Follow this and additional works at: https://digitalcommons.usu.edu/mp_presentations

 Part of the [Condensed Matter Physics Commons](#)
See next page for additional authors

Recommended Citation

Justin Dekany, Justin Christensen, JR Dennison, Amberly Evans Jensen, Gregory Wilson, Todd Schneider, Charles W. Bowers and Robert Meloy, "Variations in Cathodoluminescent Intensity of Spacecraft Materials Exposed to Energetic Electron Bombardment," 13th Spacecraft Charging Technology Conference, (Pasadena, CA, June 25-29, 2014).

This Presentation is brought to you for free and open access by the Materials Physics at DigitalCommons@USU. It has been accepted for inclusion in Presentations by an authorized administrator of DigitalCommons@USU. For more information, please contact digitalcommons@usu.edu.



Authors

Justin Dekany, Justin Christensen, JR Dennison, Amberly Evans Jensen, Gregory Wilson, Todd Schneider, Charles W. Bowers, and Robert Meloy



Variations in Cathodoluminescent Intensity of Spacecraft Materials Exposed to Energetic Electron Bombardment

Justin Dekany,¹ Justin Christensen,¹ JR Dennison,¹ Amberly Evans Jensen,¹ Gregory Wilson,^{1,2} Todd Schneider,³ Charles W. Bowers⁴ and Robert Meloy⁵

¹ *Materials Physics Group, Physics Department, Utah State University*

² *Department of Physics, Montana State University*

³ *NASA Marshall Space Flight Center*

⁴ *NASA Goddard Space Flight Center*

⁵ *ASRC Federal Space and Defense, Inc*

Abstract

Various highly insulating materials used in spacecraft construction can exhibit glow (electron-induced luminescence or cathodoluminescence) when exposed to the space plasma environment. Measurements of the absolute and relative cathodoluminescent intensity per incident electron flux of spacecraft materials are essential to predict and mitigate consequences for optical detection and for stray light contamination in space-based observatories. They also provide important information about the defect structure and electron transport properties of these materials. Previous studies have focused on how the relative spectral radiance of cathodoluminescent materials varies with changes in environmental conditions, including electron energy, current density, absorbed power density, and temperature. The present study focuses on variations associated with the materials.

We present measurements from a wide variety of thin film dielectric and nanodielectric composite samples. These include: polyimide films, neat urethane and bisphenol/amine epoxy films; bulk and thin optical coatings of disordered SiO₂; several grades of commercially available high-conductivity carbon-loaded polyimide nanodielectric composites; cyanate ester and urethane epoxy resins in graphite fiber and fiberglass composites; and multilayer dielectric/conductor composites. Comparisons of the absolute spectral intensities per incident electron flux for various materials show three orders of magnitude variation. These absolute spectral intensities for isolated samples exposed to electron fluxes comparable to solar wind intensities span the intensity of the zodiacal background in the visible and near infrared wavelength range. In general terms, we found that the relative cathodoluminescence for a given electron flux ranks from lowest to highest intensity for bulk polyimide, polyimide nanodielectric composites, disordered SiO₂, epoxy resin composites, and bulk epoxy materials.

Finally, we describe a study of the variability of a large set of similar bisphenol/amine epoxy samples exposed simultaneously, in the same space environment test chamber, to similar space-like monoenergetic electron flux conditions. The observed statistical fluctuations provide measures of both the instrumentation precision and the stochastic variations inherent to the material. This allows us to estimate the accuracy and precision to which laboratory studies may be able to determine the response of spacecraft materials in the actual space environment. It also provides guidance as to the distribution of emissions that may be expected for sets of similar flight hardware under similar environmental conditions.

*Supported through funding from NASA Goddard Space Flight Center and Marshall Space Flight Center.